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PRELIMINARY NOTES ON THREE ROTS OF JUNIPER¹

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(WITH PLATES 64 AND 65, CONTAINING 15 FIGURES)

On account of the increasing scarcity of the common red cedar (*Juniperus virginiana*), other species of juniper which have heretofore been considered worthless or of very little economic value are becoming commercially important. Any disease, therefore, which seriously injures any species of juniper that reaches a size large enough to be used even for fence posts, is of sufficient importance to demand attention.

In addition to the three rots caused by the species of *Fomes* which are discussed in this paper, there are also other rots of juniper which do much damage, but lack of sufficient data and material at this time on these diseases have made it necessary for the writers to limit this article to three heart rots of living junipers, namely: white rot, caused by *Fomes juniperinus*; yellow rot, caused by *F. earlei*; and stringy brown rot, caused by *F. texanus*.

The distribution and characteristics of the white rot, and the damage done by it to the red cedar have been previously noted by von Schrenk (Two Diseases of Red Cedar, Caused by *Polyporus Juniperinus* n. sp., and *Polyporus Carneus* Nees, Bull. 21, U. S. Dept. Agr. Veg. Phys. and Path.). The characteristics and effects of the other two rots are here reported for the first time;

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technical descriptions of the sporophores, however, have been given by Murrill in North American Flora 9: 104, 107. 1908.

The junior author is responsible for the descriptions given, and for the micro-chemical studies of the rots reported in this article. The field notes on *Fomes earlei* and *F. texanus* were made by both authors.

WHITE HEART ROT OF JUNIPER

FOMES JUNIPERINUS (Schrenk) Sacc. & Syd. Sacc.

Syll. 16: 151. 1902

Polyporus juniperinus Schrenk, Bull. U. S. Dept. Agr. Veg. Phys. and Path. 21: 9. 1900.

Pyropolyporus juniperinus (Schrenk) Murrill, Bull. Torrey Club 30: 116. 1903.

Rot white, or brownish-white in partially rotted areas, forming holes in the heart wood. These holes have white borders consisting of delignified wood tissues, which rather abruptly change both in structure and color until the normal condition of the sound wood is reached. Long, white fibers of pure cellulose extend into the cavity, which usually contains a yellowish mass, consisting of wood fibers intermixed with the mycelium of the fungus. The holes vary from one to three inches in diameter and extend longitudinally in the tree for several inches (4-6); or successive holes may coalesce into one long hole; or there may be several holes in one cross section. The white delignified tissue that borders the holes is firm and appears to be sound, but a microscopic examination shows that the middle lamellae and medullary rays have disappeared, leaving the individual tracheids with walls of pure cellulose. The bordered pits are also corroded until they appear as regular perforations in the tracheids.

Later the delignified wood is gradually destroyed, thus producing the holes in the trees. There seems to be a radial limit to the activity of this fungus as the holes increase in size up to a certain diameter, beyond which all enzymotic action stops and the hole ceases to grow in diameter, but may continue to grow longitudinally. Around the edges of such holes the delignification and the absorption of the resulting cellulose seem to progress at about the same rate, as the attacked wood gives only a faint reaction for pure cellulose. This description is made from a portion of the type material of the rot.

Pileus woody, ungulate, length 3-7 cm., breadth 5-9 cm., thick-

ness 2-4 cm., narrowly attached; surface tomentose, sulcate, reddish-brown to dark brown; margin obtuse, velvety, melleous to ferruginous, plane below; context woody, reddish-brown, 0.5 to 2 cm. thick; tubes indistinctly stratified, 0.5 to 1 cm. long each season, melleous within, reddish-brown in older layers, mouths circular, 2-3 to a millimeter, edges obtuse, entire, melleous to fulvous; spores very abundant, fulvous, smooth, spheroid to broadly ellipsoid, somewhat angular, $5-6 \times 6-7 \mu$, cystidia few, nearly colorless, $100 \times 20 \mu$, pointed (in specimen at hand), somewhat encrusted. This description is drawn from a specimen collected at Sparrow Point, Md., by Dr. Perley Spaulding in 1908.

TYPE LOCALITY: Tennessee.

HABITAT: Trunks of living trees of *Juniperus virginiana* L.

DISTRIBUTION: Tennessee, Kentucky, and Maryland, probably more or less prevalent throughout range of host. Only 3 or 4 sporophores of this fungus have ever been reported, but the rot is known to occur in the states mentioned. The sporophores form from a dense whitish weft of mycelium, which has grown out through the wood of a dead branch or from a knot hole.

YELLOW ROT OF JUNIPER

FOMES EARLEI (Murrill) Sacc. & D. Sacc. Sacc.

Syll. 17: 119. 1902

Pyropolyporus Earlei Murrill, Bull. Torrey Club 30: 116. 1903.

Rot light brown, slightly paler than the unchanged heart wood, forming longitudinal holes from one to several inches in diameter and two to several inches in length; holes, as a rule, partially filled with undecomposed wood particles which are often matted together by the light yellow mycelium of the fungus; rotted areas usually abruptly limited by annual rings, thus making longitudinal tube-like holes several times longer than broad; both heart and sap wood may be attacked, but usually only the heart wood.

The enzym from this fungus attacks the medullary rays and the walls of the bordered pits, gradually enlarging the pits until only clear round holes are left. These holes gradually coalesce, and the tracheids are thus divided longitudinally, leaving jagged strips of tissue, the uncorroded corner remnants of the walls where three or more tracheids joined. The enzym does not delignify the walls of the tracheids but corrodes the tissues as a whole; neither are the middle lamellae destroyed as in the white rot of juniper.

Pileus woody, broadly ungulate to semi-cylindrical in old sporo-

phores, broadly attached, plane to slightly convex below, length 2-12 cm., breadth 3-12 cm., thickness 2-8 cm.; surface concentrically sulcate, very rimose, fulvous to brownish-black; margin broad, obtuse, luteous to dark brown, tomentose; context woody, fulvous, at length becoming dark reddish-orange, 1 to 1.5 cm.; tubes faintly or not at all stratified, from 1 cm. long in very young sporophores to .2-.5 cm. in older ones each season, 1 to 2 to a millimeter, yellow within during first season, later becoming brick-red, mouths circular, yellow, edges obtuse, thin; spores very abundant, spheroid, broadly ovoid or ellipsoid, smooth, $5-6 \times 6-8 \mu$, pale yellow, cystidia apparently none.

TYPE LOCALITY: El Capitan Mountains, New Mexico, at an altitude of 2100 meters.

HABITAT: Trunks of living trees of *Juniperus monosperma* (Eng.) Sarg., *J. utahensis* (Eng.) Lemm., and *J. sabinoides* (H.B.K.) Sarg.

DISTRIBUTION: Texas, New Mexico (very common), Arizona, and Colorado.

The sporophores of this fungus are fairly common wherever the rot is found, and are attached directly to the bark on areas where the rot has reached the surface of the tree. They are located usually within ten feet of the ground in narrow longitudinal furrows or depressions in the trunk. The damage to the trees is often extensive; in some instances the trees are weakened to such an extent, especially near the butt, that they bend or break at this point; in any event a tree thoroughly infected by this fungus is unfit for commercial purposes. This rot is apparently rare in Texas, as only one sporophore has been found. It is replaced here by *Fomes texanus*.

STRINGY BROWN ROT OF JUNIPER

Fomes texanus (Murrill) Hedgc. and Long

Pyropolyporus texanus Murrill, N. Am. Fl. 9: 104. 1908.

Rot reddish-brown, light brown adjacent to the sound wood, characterized by layers of badly rotted wood alternating with more or less sound layers. The rotted regions correspond approximately to the spring wood of the annual rings and the sound layers to the summer wood, thus making a species of stringy brown rot arranged in concentric rings in a cross section view.

In the earlier stages of the rot, the wood is light brown and under the hand lens is seen to consist of small pockets of rotting tissue in the spring wood, thoroughly permeated with the fulvous mycelium of the fungus; at this stage the rot somewhat resembles that produced by *Polystictus abietinus*. As the rot advances, these pockets coalesce longitudinally, thus destroying more or less completely the spring wood.

This rot, from the material at hand, does not seem to produce holes in the tree but leaves the wood in the alternate-layered condition above described. Later, certain fungi, especially species of *Poria*, may attack and completely destroy the diseased wood, thereby leaving the tree in a more or less hollow condition. This fungus usually attacks only the heart wood, but also extends into the sap wood, a condition which always arises wherever a sporophore is formed. The entire heart wood for many inches may be attacked and take on the characteristic reddish-brown layered appearance previously noted.

A micro-chemical examination of the diseased wood shows no delignification, but the enzym seems to attack first the resinous or gum-like contents of the medullary rays, then their walls and thence passes to the tracheids, where small areas in the spring wood are destroyed. The middle lamellae are not attacked by the enzym, but the walls of the tracheids seem to be uniformly corroded, the relative proportion of lignin, cellulose, etc., in their walls changing not at all. This description was made from material collected at Austin, Texas (type locality), on *Juniperus sabinoides*, but the characteristics of the rot are the same on all the hosts examined.

Pileus woody, more or less ungulate to sub-cylindrical in very old specimens, broadly attached, plane to slightly convex below; length 3-13 cm., breadth 4-11 cm., thickness 2-6 cm.; surface, when young, tomentose, melleous, smooth, becoming sulcate by the yearly accretions, older portion reddish-brown to black, glabrate, strongly rimose; margin very obtuse, rounded, melleous, tomentose, smooth; context woody, melleous to dark luteous, zonate, 1.5-2.5 cm. thick; tubes evenly but faintly stratified, 3 to 5 mm. long each season, concolorous without luster, mouths circular, 4-5 to a millimeter, edges obtuse, entire, melleous to fulvous; spores rarely found, globose, smooth, 3-4 μ , cystida none, hyphae brown, 5-7 μ in diameter.

TYPE LOCALITY: Austin, Texas, on *Juniperus sabinoides*.

HABITAT: Trunks of living trees of *J. sabinoides*, *J. monosperma*, and *J. utahensis*.

DISTRIBUTION: Southwest Texas, New Mexico, and Arizona. Very common in Texas and New Mexico.

The sporophores are attached to the bark, usually within ten feet of the ground, and occur on dead tissue where the fungus has grown outward from the heart wood into the bark, thereby killing the living tissues of the tree, at this point both sap wood and bark are permeated with the reddish-yellow mycelium of the fungus. The sporophores are usually located in the longitudinal depression or furrows which are found on most junipers. They were rarely found associated with an old dead branch or knot hole. The damage done by this rot in certain localities is very great; often many mature and over-mature trees are weakened at the butt to such an extent that they bend, split, and flatten near the ground and either fall or remain in a leaning position; later other fungi or fire kills the trees outright or hollows them out so that they are easily blown down. Even when the injury is not sufficient to produce such damage, the wood of many trees attacked by this fungus is rotted to such an extent that it is unfit for commercial purposes.

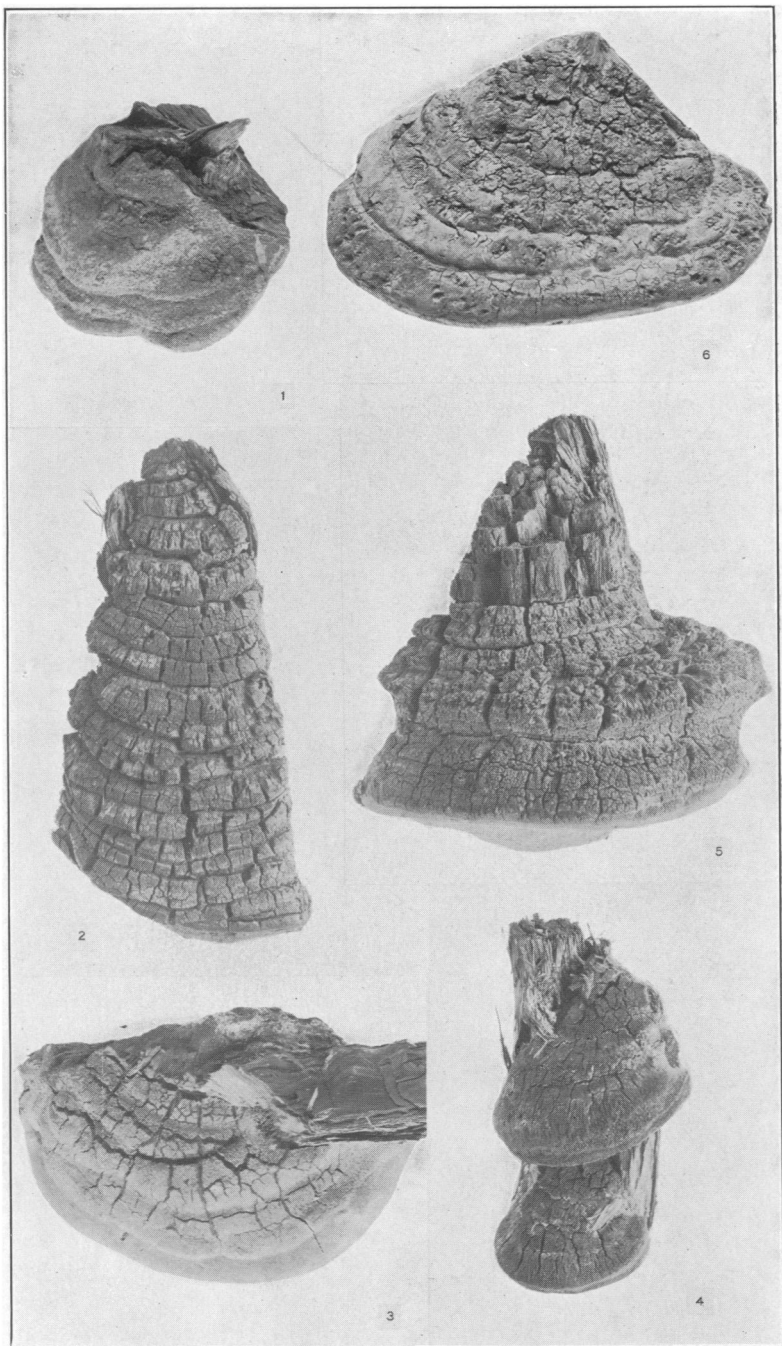
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EXPLANATION OF PLATE LXIV

- Fig. 1. Sporophore of *Fomes juniperinus*. $\times \frac{1}{2}$.
 Fig. 2. Sporophore of *Fomes texanus*, old and weathered specimen. $\times \frac{1}{2}$.
 Fig. 3. Sporophore of *Fomes texanus*, young specimen two or three years old. $\times \frac{1}{2}$.
 Fig. 4. Sporophore of *Fomes earlei*, young specimens one or two years old. $\times \frac{1}{2}$.
 Fig. 5. Sporophore of *Fomes earlei*, old and weathered specimen. $\times \frac{1}{2}$.
 Fig. 6. Sporophore of *Fomes earlei*, young specimen three or four years old. $\times \frac{1}{2}$.

EXPLANATION OF PLATE LXV

- Fig. 1. *Fomes texanus*, longitudinal section of sporophore. $\times \frac{1}{2}$.
 Fig. 2. *Fomes earlei*, longitudinal section of sporophore. $\times \frac{1}{2}$.
 Fig. 3. *Fomes juniperinus*, longitudinal section of sporophore. $\times \frac{1}{2}$.
 Fig. 4. *Fomes texanus*, surface of hymenium showing pores. $\times 2$.
 Fig. 5. *Fomes earlei*, surface of hymenium showing pores. $\times 2$.
 Fig. 6. *Fomes juniperinus*, surface of hymenium showing pores. $\times 2$.
 Fig. 7. *Fomes texanus*, longitudinal section of wood showing rot. $\times \frac{1}{2}$.
 Fig. 8. *Fomes earlei*, longitudinal section of wood showing rot. $\times \frac{1}{2}$.
 Fig. 9. *Fomes juniperinus*, longitudinal section of wood showing rot. $\times \frac{1}{4}$.



POLYPORES THAT ATTACK JUNIPER



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